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Pre-Service Primary School Teachers' Perceptions of Their Understanding of an Enquiry Based Approach to Teaching Primary School Science and Its Influence on Their Field Teaching Experiences

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Abstract

This study seeks to explore pre-service primary school teachers' perceptions of their understanding of an enquiry based approach to teaching primary school Science. The study also seeks to identify how pre-service primary school teachers perceive the effectiveness of their University Science courses in preparing them to teach science using an enquiry approach. Participants were pre-service teachers enrolled in the B.Ed programme at The University of Trinidad and Tobago. Data were collected using semi-structured interviews. The data revealed that the teachers understood the concept of guided enquiry and knew how to develop lesson plans that incorporate that approach. Although the teachers believed that their courses prepared them adequately to teach primary school Science using enquiry, they encountered problems because of the lack of adequate resources.

Keywords

preserve teachers, perceptions, enquiry based approach, primary school science, semi-structured interviews

1. Introduction

Brickman, Gormally, Armstrongand and Hallar (2009) statedthat calls for reform at the tertiary level of education created a pedagogic shift from teacher centred classrooms to student centred ones. They advocated for a constructivist, rather than a transmission oriented model. This model requires students to be active learners engaging in concrete tasks. They also pointed out that the approach enables students to make informed decisions about how science impacts their lives and to use scientific knowledge to promote problem solving. This type of learning is best accomplished by using student centred active learning strategies such as problem based learning, case based learning and enquiry based learning.

As part of this global reform initiative, the four year pre service Bachelor of Education degree at the University of Trinidad and Tobago (UTT) also adopted an enquiry approach to Science teaching. The first challenge in implementing this approach was the level of secondary school preparation of the students, the majority of whom came with weak background knowledge in science (George, Quamina, & Aiyjina, 2003). Therefore, the curriculum was structured to provide the pre-service teachers with experiences of practical, hands-on enquiry based activities as well as relevant theoretical understandings of the philosophy, psychology and pedagogy of the subject. The curriculum also addressed the following: learning and development, structure of the primary science curriculum, nature of Science and scientific knowledge, rationale for teaching science, enquiry based approach to teaching primary Science, use of the 5E learning cycle in planning enquiry science lessons, a constructivist inspired approach to teaching science and ways of evaluating students learning in science. Representative topics in science were dealt with in the content courses. There was the expectation that the science courses should help teachers to develop a comprehensive subject knowledge base and also an understanding of the links between subject knowledge and the teaching learning process. The programme of studies in science at the UTT was closely aligned to the primary science programme which pre-service teachers would be expected to teach on completion of their studies at the University.

2. Literature Review

Science teaching is perceived by many people to be a complex and dynamic activity which is “not easy” to do. In order to teach science a teacher must possess a wide array of knowledge and skills (Guzey & Roehrig, 2009) referred to the work of Lee Schulman (1987) in which he identified seven knowledge bases as being relevant to the teacher. Two of these seven knowledge bases, science content knowledge and general pedagogical content knowledge were identified as having direct relevance to this study.

2.1 Issues Relating to General Pedagogical Knowledge

The major finding from the research on Science teaching was that an understanding of the Nature of Science (NOS) was an essential aspect of Science teaching (Shim, Young, & Paolucci, 2010; Harlen, 2006; Tan & Boo, 2003; Lederman, 1999), they also found while some teachers had a reasonable understanding of the nature of science, it was not very evident in their classroom practice. Furthermore, Howell-Richardson, Christodoulou, Osborne, Richardson and Simon (2009) found that increasingly, the average citizen has become part of the global population who are curious about a range of scientific issue such as cloning, stem cell research, and genetic manipulation. In other words, basic knowledge of Science is an educational enhancement of all citizens. Howell-Richardson, Christodoulou, Osborne, Richardson and Simon believes in order to produce citizens with such scientific knowledge would require a curriculum in which teachers of Science pay considerably more attention to the development of an understanding of the nature of Science.

2.2 A Case for Subject Knowledge

In the introduction to the literature review section reference was made to the work of Schulman (1987) who pointed out that subject knowledge was among the different kinds of knowledge the teacher needed in order to teach effectively. It can be said that one cannot teach a subject that one knows nothing about. In addition, in order to manage the enquiry learning process in the classroom teachers should have a thorough understanding of not only pedagogical content knowledge but aloof the subject content.

Appleton and Harrison (2011) explored the extent to which "activities and units that work" played a role in primary and secondary teachers' planning and implementation of a science syllabus. The researcher who made observations of the classroom teaching reported that aspects of the content were glossed over, and critical aspects of the pedagogy embedded in the activity were not followed. Poulson (2001) recommended that reform efforts must ensure that acquisition and development of specific subject knowledge were at the centre of provision for initial teacher training. She found that many primary school teachers had limited knowledge of some areas of the curriculum and did not feel confident to teach them. This was especially true for teaching Science and Math. The researcher reported that trainee teachers' subject knowledge across a range of subjects was limited when they were tested at the beginning and also at the end of their training. The researcher further observed that teachers appeared to be teaching what they did not know.

2.3 National Primary Science Survey Preliminary Report

According to this report teachers in England felt least prepared to teach the physical sciences topics. The teachers gave a more favorable response to teaching topics in the biological sciences. Ginns and Watters (1995) also argued that teachers should have a sound conceptual knowledge base in Science in order to implement effective problem solving strategies in the elementary science classroom. However, most elementary school teachers demonstrated a range of inaccurate concepts in Science that formed important components of the primary school Science curriculum. These teachers also had an understanding of scientific concepts that were not much different from that of the students in grades nine or lower. In addition, the teachers also lacked scientific reasoning and problem solving skills. According to Ginns and Watters (1999), if primary school teachers are to promote conceptual understanding in Science through enquiry teaching they themselves should possess a sound understanding of basic Science concepts.

3. Methodology

I conducted the research because I wished to gain information about my pre-service primary school teachers' perceptions of their understanding of teaching primary school Science using enquiry based pedagogy. I had to investigate the meaning pre-service teachers made of their experiences, understandings, perceptions and beliefs about enquiry based teaching of primary school science. Berg (2006) pointed out that quality was essential to "who, what, when, where" of something. In the case of

the life-world, he pointed out that focus was on the meanings individuals made of their experiences. Since I wished to find out pre-service primary school teachers' perceptions of enquiry teaching, I saw my study as being non-positivist and falling within a qualitative paradigm. In reference to an interpretative paradigm, Cohen and Manion (2007) stated that a central endeavour of the interpretative paradigm was to understand the subjective world of human experiences.

3.1 The Research Site

The study was conducted with pre-service teachers who were pursuing a Bachelor of Education degree. The study was conducted in the researcher's classrooms. The participants were students who had chosen primary school education as their specialization of which Science was a core subject. All the participants in the study had completed their Science courses.

3.2 Data Collection and Instrument

Semi structured interviews were used to gather information about pre service teachers' knowledge, values, beliefs and perceptions of their understanding of enquiry pedagogy in teaching primary school science. Collecting data through the use of open ended questions in a semi structured interview allowed participants to describe their experiences freely without the constraint of having to choose options provided by the interviewer. In addition, these face to face interviews allowed me the added advantage of shifting the focus based on participants' responses (Bryman, 2008). The strategy helped to keep the interview focused and ensured essential data were collected. I was also able to probe into issues raised. Such opportunities would not have been possible if I had used a self-completed questionnaire. The interviews lasted twenty to thirty minutes and were held in a quiet, private room on the campus during the final semester of the 2010-2011 academic year. I ensured that the participants were comfortable and that they again consented to the interviews being audio-taped.

3.3 Participants

The participants were four female pre-service teachers (See Table 1). They were selected by a process of purposive sampling referred to by Cohen and Manion (2007). This was a non-random strategic method of sampling that allowed me to select participants who were considered knowledgeable of the topics and had the capacity to narrate and articulate their experiences. As students of the institution they were easily accessible and convenient to me in terms of time and cost. The object of the project was explained to them. Assurance of anonymity and confidentiality was given to them. It was made clear to them that there were no risks or disadvantages would be incurred by their participation.

Table 1. Profiles of Participants

Participants	Age Yrs	Gender	Qualifications (inclusive of science)
P1	27	F	4 AL, 7 OL Integrated Science Included
P2	28	F	2 AL, 7 OL Integrated Science and Human and Social Biology
P3	29	F	6 O L Integrated Science
P4	41	F	5 OL Human and social Biology

3.4 Issues of Ethics

As an educator and researcher, I felt committed to treat participants with dignity regardless of my relationship with them. The participants in the study were students whom I taught. I expected that issues of bias and subjectivity would arise. I assured them of the confidentiality of the information they provided and also assured them that their honest views would not be taken personally nor would it affect their assessment in their Science courses.

Since I conducted the research at the institution where I worked inherent in the study was my insider perspective. In carrying out the research in my institution, I ensured that I did not over identify with the culture of the institution, as recommended by Potts and Sikes (2008). My insider positioning allowed me easy access to particular persons. I had pre-existing relationships that enabled me to move around the institution and to have a wide range of information available to me. It also enabled me to have pre understanding of my participants' views on their experiences so that I was able to approach the task with a detached but a rich understanding of the issues that were under investigation. I believed this enabled a deeper and more insightful exploration of the issues being investigated. I considered the range of issues that had the potential to become problematic and tried to manage them.

3.5 Positionality

In reflecting on my positionality, I referred to the work of Sparks (2009) who stated that positionality was significant, and that it was important for the researcher to discuss his position with the reader because the researcher's history, subjectivity and theoretical positioning were vital resources for understanding those under their study. I am a Science educator, the holder of a natural science degree and post graduate qualification in science teaching. I have a strong orientation to the scientific enterprise. Science is a discipline that is traditionally positivist and being educated in science I was accustomed to the scientific method of enquiry as a means of acquiring knowledge. From that point of view I was somewhat more disposed to quantitative methods. As a science instructor, I viewed science as an essential aspect of everyday living. It has important consequences for everyone especially through its applications. I believed science should feature prominently in the curriculum of the schools and teachers should be well prepared to teach it. I naturally have high expectations from teachers and would be surprised and even disappointed when it was lacking. Throughout the research I maintained a commitment to a responsible enquiry for the advancement of my profession.

3.6 Data Analysis and Findings

Data for the study were gathered from semi structured face-to-face interviews and from written reports. The data analysis was organized along the lines of the research questions and on a question by question basis. Interview transcripts were read and categorized by research questions and themes which emanated from them. In the process of the analysis, I considered all participants' responses to each research question. All the data relevant to each research question were put together to facilitate identification of consistencies and differences in participants' responses. Where participants' responses were quite similar, only one or two typical responses were presented. As the data were organized by research questions, connections and relationships both within and between categories were explored and reported in the results section of this chapter.

4. Results

4.1 Research Question One

Research Question One: How do pre-service teachers understand teaching primary school science through an enquiry approach? (Appendix A interview questions 1-13)

Two themes emanated from this research question. This theme was fundamental to enquiry in primary science teaching. Analysis of participants' responses during interviews showed that they knew that science was knowledge about the physical world and it had had components of knowledge skills and attitudes. They gave examples of the kinds of knowledge, for example, matter and energy living things and ecosystems. They identified some attitudes and skills science teaching sought to develop in children such as curiosity and persistence. They described some simple behavior that typified the attitudes of a child who demonstrated them. Participants were unanimous in expressing that scientific knowledge was tentative and involved observations which were characteristics of science. Participant 1 said:

It is socially and culturally biased because some things you find in this area may not be applied or pertinent in another area. There is a difference between science and opinion because sciences wanting to find out and it is based on evidence, opinion is your thoughts and your ideas minus the evidence part, you don't have evidence to support what you are saying. Science is a search for knowledge about the world and how it functions. It involves such things as matter and energy, living things and ecosystem. It involves skills like classifying information you gather, inferring and communicating.

Participant 3 believed that: *It builds on attitudes, curiosity and persistence and critical thinking*. And Participant 4 opined that:

Science deals with observations, classification, and communication. Science involves making observations and so on; it is subjective because scientists put their own values in their work. They do not give up, they would always try to finish the task to the best of their ability. They would be more motivated and energized. They would want to continue.

Finally, Participant 2 stated that: *It is tentative and is subject to change, Curiosity-The child who is*

always asking questions. Persistence- sticks to whatever she/he wants to know.

When asked about the difference between science and opinion the participants unanimously agreed that there were differences. They referred to evidence as a distinguishing feature between opinion and science.

The following remarks by Participants 2 and 3 captured the unanimous feeling:

Scientific knowledge is proven by investigation and fact but opinion is just anybody's way of thinking…Scientific knowledge is based on evidence whereas opinion is subjective and based on feelings.

When asked about incorporating the nature of science into their teaching they sounded unsure and it seemed as if they did not incorporate it in their teaching but left it to chance. They also did not address my question in a direct way. The following were the responses from each participant to the interview question. "How do you include the nature of science in your teaching?"

P1 *You are not conscious that you are planning for the nature aspect of science. I think it is always there*;

P2 *I think to some extent yes*;

P3 *I think it occurs naturally*;

P4 *Yes, because I always use different strategies depending on the students' abilities*.

Even though participants had some understanding of the nature of science it was clear from their responses that they did not incorporate it in their instructions.

4.1.1 Perceptions of Understanding of Enquiry Based Pedagogy

This theme, also encompassed in Research Question 1, related to pre service teachers' understanding of an enquiry based approach to teaching primary school science. Participants were asked what they thought was the contemporary approach to teaching primary school science. All the participants in the sample correctly named the contemporary approach to teaching science as "an enquiry based approach". The following were typical responses:

After successfully naming the approach, their response was followed by a more complete question which was what was their understanding of an enquiry based approach to teaching science. Participants gave a wide range of views of enquiry pedagogy. They stated the essential elements of scientific enquiry.

An enquiry based approach focuses on the student or the learner engaging in a question, responding to the questions, formulating explanations and inferences and the learner most likely will be engaged in raising and answering questions, formulating explanations from evidence, communicating explanations and also comparing their explanations to scientific knowledge".

When asked to describe what enquiry activities looked like in the classroom (See Appendix A interview questions 9 & 11) a wide range of responses that contained many important features of enquiry were made. Participants reported that:

Each child would come with her/his own knowledge and misconception about science, an observer

looking on would see attentive students asking questions, a more student centred class where students learn by doing and the teacher acts as facilitator.

Furthermore, in an enquiry approach:

Children feel excited and impatient when they see resources, they want to explore.

One of the participants, Participant 4, reported that children bring misconceptions to the classroom. She also stated that when incidents like this occur, they present opportunities for the teacher to engage the students in constructivist activities/conversations. However, the participant did not articulate how the misconceptions were resolved. Participants were questioned on some fairly specific issues of the enquiry process (Interview question 12 Appendix A). When enquiry pedagogy was used in the classroom questions were asked that elicited responses about raising questions, planning and carrying out activities, proposing explanations, evaluating and results which participants mentioned. In what follows were some typical responses about who raised the questions and who carried out the activities to answer the questions raised. The following were two typical responses that were obtained:

Raising questions

P1 *The teacher would pose the question in the beginning and the question would lead to other questions*;

P2 *The teacher and the student will come up with the questions for investigations*;

The above responses held well for partial or guided enquiry. There were no responses where participants said that the children proposed their own questions for investigation, that is, full or open enquiry.

1) Planning the investigations

Participants generally responded that the planning of investigations was a function of both teachers and pupils which was a characteristic of guided enquiry. When teacher provides input the enquiry is guided inquiry. The following responses were obtained from the participants:

P3 *Both children and teachers because I think there is supposed to be some kind of intervention on the part of the teacher in terms of the children being guided*;

P4 *Sometimes it would be the teacher and sometimes it would be the pupils*.

2) How were data collected?

When asked about data collection in enquiry activities, participants responded that data were collected by observations and measurements which were accepted methods for collecting data and that the senses were used. It was implicit from their responses that the children collected the data.

P1 *The children don't engage only in looking at what is happening but they use their senses to collect data, they feel, they touch and they use apparatus to measure*.

Observations involved collecting data through the senses not merely watching.

P2 *They listen, feel, smell, they use equipment for measuring, measuring tape, cylinder, thermometer*.

3) Formulating explanations

When asked about who formulated the explanations for the questions raised and on what basis, all the

participants responded that the children used evidence and proposed their own explanations based on observations and evidence they gathered. Typical responses were:

P1 *After the observation they explain the activities and what they have found and justifying it in terms of what of they have found*.

P2 *They based their explanations on evidence they gathered*.

P3 *The children based explanations on what they observed they would explain and propose explanations themselves*.

P4 *They explain based on what they have observed and measured*.

4) Communicating data

The participants were unanimous in their views about how data were communicated after investigations. There were several ways to communicate the results of enquiry. Usually data are communicate either as a written report or as an oral presentation. Two typical responses of participants were:

P1 *It depends, it could be orally or by writing*;

P2 *Sometimes they do presentations or written reports*.

The participants showed that they had an understanding of the enquiry processes (the pedagogical knowledge) to involve their children in carrying out guided enquiry activities.

4.2 Research Question Two

Research Question Two: (Appendix A Interview questions 14-15). How well have pre service primary school teachers' university science courses equipped them to teach primary school science using an enquiry pedagogy?

Two sub themes emerged from this research question. The first had to do with the methods course and the second, with the content course.

4.2.1 Perceptions of Methods Course in Understanding Enquiry Teaching

All the participants found that the methods course was helpful in preparing them to teach using enquiry.

P1 *It helped a great deal*, *this course, to an extent, helped us to understand the whole method of enquiry, to actually apply it in the classroom*;

P2 It assisted me in learning ways in which children can learn content;

P3 *It helped a great deal, we learned more conceptual things there*.

Participants were asked to state and explain what instructional model they used to plan their enquiry science lessons (Interview question No.13, Appendix A). The learning cycle is a tool that is used for planning and teaching enquiry science lessons. This topic was addressed in their science methods course and referred to in the introductory chapter. Participants named the steps and explained satisfactorily the meaning of each of the E's of the learning cycle (E's are referred to as the steps or phases in the cycle). They identified benefits of the learning cycle and some theories that supported it. Some typical responses follow:

P1 *We use the learning cycle, the 5E learning cycle*;

P2 *I used what is called the 5E learning cycle*;

When asked to explain the meaning of the 5E learning cycle, participants were all able to do so.

P3 *There is Engage which has to do with getting the students attention, then the students would explore, there is some kind of activity where they explore the concepts that they were learning, then there would be Explanations of what they did and then if time permits we sometimes Extend, throughout the exercise we would evaluate*;

Another participant's response to the same question was as follows:

P4 *Engage is where the students' interest is captured and the topic is established, Exploring is where the students are allowed to construct knowledge. Explain is where the students are asked to explain what they have discovered. Extend is where students are asked to apply what they have learnt in a different situation, Evaluate is where the instructor observes each students knowledge and understanding and it helped them to accept whether what they have learnt is true*.

All the participants stated that there were benefits in using the 5E learning cycle as an instructional model.

P1 *Yes, I think the way it is laid out and moves from one step to the next allows you to know that the student is moving from constructing knowledge to applying the knowledge and you know that they understand when you evaluate*.

In response to the same question another participant stated:

P1 *The nature of science is reflected in it (the 5E learning cycle); it helps to bring out scientific concepts where students construct knowledge without the teacher actually telling them*.

All participants identified theories that support the 5E learning cycle. The learning cycle rests on constructivism as its theoretical foundation. Constructivism is regarded as a model of how humans learn (Martin, Sexton, & Franklin, 2009) Typical responses were:

P1 *It is basically a constructivist approach where I think children would be able to construct their own learning*;

P2 *The most prominent would be constructivism, it is based on brain based learning and hands- on activities and multiple intelligence*;

P3 *It represents the way children learn, it lent support to constructivist teaching*.

Participants' responses demonstrated an understanding of enquiry pedagogy in teaching primary school science. They understood the 5E learning cycle, its use in planning enquiry science lessons, its benefits in representing science to their students and theories that underpinned its philosophy. They were asked to identify some other topics they did in their methods course which they thought were particularly helpful to them. All the participants identified topics that they felt were relevant to them. Most of the participants named the same topics. Some responses follow:

P1 *The rationale for teaching science at the primary school helped, the processes of science, the concept of enquiry, evaluation of children's learning in science, the role of the science processes in formulating concept*;

P2 *We learned the psychology of learning science, how constructivism is important to enquiry based learning in science, how to plan lessons and how to teach them*;

P3 *We learned the relationship between science technology and society, a rationale for teaching science at the primary school, the science processes, concept of scientific enquiry*.

Those were only some topics the participants studied in the Science Methods course and found them to be critical to teaching science. Participants thought that their Methods course helped them and it was sufficiently in-depth. However, they thought there should be more practical applications.

4.2.2 Perceptions of Participants' Preparedness to Teach Science in Terms of Their Content Course

All the participants stated that their content courses were helpful in preparing them to teach primary science using enquiry. They stated that the course clarified things they did not learn and understand previously. Typical responses were as follows:

P1 *I think the content courses helped us to understand the content itself in great depth. For example when we did energy with all the resource material that you all brought in the class for us and you all showed us how it works and we actually got to use the resources and apply it I think that helped*;

Another participant reported on the same question.

P2 *The content courses helped because it clarified things that I did not know previously for example I did not know much about earth and space whereas topics like living things and ecosystems I had prior knowledge so that was just like a refresher*.

1) Areas participants said they found were difficult to teach

Participants said they generally coped better with the biological sciences topics in their content courses than the physical sciences topics. Research carried out by Sharp and Hopkin (2007) and Ginns and Watters (1995) confirmed similar findings in their studies. However, there were some areas in the content courses that posed challenges. Participants indicated some areas of the physical sciences were more challenging than the biological sciences for them to learn and teach.

P1 *For me energy is a challenging topic, electricity and heat. Heat transfer and getting that whole concept*;

P2 *I found things like structures and mechanism were challenging for me, also matter and materials*;

P3 *That would be the physical sciences; I would say matter and materials, energy, light and electricity*;

The participants indicated that the biological science topics were easier for them to teach;

P4 *Those two, mostly living things and ecosystem proved less challenging*.

4.3 Research Question Three

4.3.1 Factors That Impede Their Teaching of Science in Their Field Experiences

Lack of resources was cited as a major factor that worked against their teaching of Science during their field experiences. The teaching of Energy was given as an example where resources were particularly scarce. The participants also claimed that because Science was not examined in the high stake Secondary Entrance Examination (SEA) it had come to be regarded as a "back burner" issue by some teachers in the schools where they did field experiences. If resources for teaching were also scarce, and

the curriculum of the school did not emphasize Science, the pre-service teachers would not have the opportunity to put their newly acquired knowledge into practice during their field experiences. The following responses were given.

P1 *The teaching of Energy, getting the concept, resources were lacking*;

P2 *There were not enough science resources in the schools, For one lesson had to make the resources and that constituted a problem, They do not do a lot of Science at the school. The focus is more in the core areas because those are the areas for the SEA examination, Science is neglected. Science is allowed to be taught up to standard three*;

P3 *The teaching of energy and structure and mechanism inhibited my teaching of science. The time was a factor. They do not priorities Science. They put a small amount of time for science and they just don't have resources and they don't bother*;

P4 There were not enough resources because in the schools they don't teach science as often as they were supposed to do.

4.3.2 Factors Participants Felt Facilitated the Teaching of Science

With respect to the above question the participant's responded that the children made the teaching easier. The hands-on activities and the relevance of the topics were other factors that facilitated their teaching. They responded as follows:

P1 *I think it was the teaching of science using enquiry based pedagogy*;

P2 *I would say it was the children themselves, they had a natural inclination for the subject, by nature they are curious, a lot of it was hands on so they enjoy that part, some of the topics had things that were relevant to them*.

P3 *I would say it was the experiments we did, I was well prepared, and I enjoyed teaching science and the students, as well, were well motivated*.

Do you think your Science courses at the university, methods and content prepared you sufficiently well to teach the primary school science?

P1 *I think that the science courses that I did at UTT did prepared me well. They were in depth, but I think we need some more practical work*;

P2 *I was comfortable with all the topics, the content and the pedagogical content topics. The information provided was sufficient. We did have sufficient knowledge to teach lessons*;

P3 *I would say the science courses prepared you very well to teach. I think there should be an additional course because there was too much information*;

P4 *I would say I was well prepared. The science courses here prepare you adequately to teach*.

5. Conclusion

The results showed that participants generally understood the nature of science and the characteristics of scientific knowledge. They identified the elements of guided enquiry and some features of open enquiry activities. They believed that the university science courses proved to be effective in preparing

them to teach science at the primary school. The physical science topics presented challenges for them to learn and also teach. Their responses supported the physical science topics proved more challenging to teach. Also inadequate resources for teaching science in some primary schools posed problems for effective teaching of Science. Participants stated that pressure brought by high stake examination in some primary schools resulted in reduced time and low motivation for teaching Science.

5.1 Implications for the Classroom

Participants should work collaboratively to overcome constraints of resources and limitations of the environment in teaching enquiry science. They should place more attention on the nature of science and sustain that attention throughout the Science courses. Teachers should also make conscious efforts to diminish the amount of control they exercise over their learners in order for the learners to assume greater responsibility for their learning and become more capable of carrying out independent open enquiry activities. The study showed that there were problems associated with learning and teaching topics in the area of the physical sciences. It is, therefore, recommended that appropriate strategies be identified and implemented in pre service teacher education courses that will enable them to acquire an understanding of concepts in the area in keeping with the concepts held in the scientific community.

Ginns and Watters (1995) found that topics in the physical sciences were well suited to developing reasoning and problem solving skills which are essential aspects of scientific literacy. Since topics in the physical science proved problematic for teaching and learning, some research could be done to isolate the particular topics, and strategies should be explored with a view to present them to pre service teachers so they can be more easily understood and taught during field experience. The role of hands on activities and assessment of hands on activities are areas for further investigations. Many of the participants believed that routine, mindless laboratory bench work was considered to be enquiry teaching. The concept of what constitutes practical work should be revisited and possibly expanded in light of the existing technologies like the internet and virtual laboratory.

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Appendix A

Interview questions:

1. What do you understand by the term science?
2. What issues would you say fall under the purview of science?
3. After a scientist develops a theory do you think it ever changes? Explain.
4. What would you say about the nature of scientific knowledge?
5. What do you think is the difference between scientific knowledge and opinion?
6. How do you think scientist use creativity in their work?
7. How do you include the nature of science in planning your teaching?
8. Does your perception of your pupils influence the way you teach them?
9. When children are doing science how do you think they see themselves?
10. What is the contemporary method or approach to teaching primary school science?
11. If children are doing science using inquiry, what would an observer expect to see?
12. Who raises the question to investigate? ii Who does the planning of the activity? iii Who carries out the investigation? iv Who proposes explanation? v Who evaluates ? vi Who communicates?
13. What planning frame work do you use to develop your science lesson plans?
14. How do you think your science education content courses help you to understand the concepts in science?
15. How do you think your science education methods course help you to understand the enquiry nature of science and the way science should be taught?
16. What science content areas pose the greatest challenge for you to teach?
17. What are some factors (or barriers) that inhibit your teaching of science?
18. What are some factors that facilitate your teaching of science?
19. Do you think your science courses prepared you adequately to teach the primary science?
20. What areas of your science courses should be improved in order to make you feel more comfortable to teach science at the primary school?